

CLAIMS:

1. A breathing assistance apparatus adapted to deliver humidified gases at a desired level of humidity or at a desired temperature to a patient using open loop control comprising:

5 a humidifier having an electrical input power and capable of humidifying said gases up to a level of humidity prior to delivery to said patient, said level of humidity depending on said input power to said humidifier, and

a controller or processor configured or programmed to:

10 (a) determine a parameter relating to the flow rate of said gases through said apparatus;

(b) determine based on at least said parameter the required electrical power input to said humidifier to deliver said gases to said patient at a level of humidity or at a temperature substantially similar to said desired level of humidity or said desired temperature;

15 (c) supply as said input power to said humidifier a level of power substantially similar to said determined power input to said humidifier.

2. A breathing assistance apparatus as claimed in claim 1 further comprising:

a conduit for conveying said humidified gases from humidifier to said patient

20 a conduit heater having an electrical input power, and being associated with said conduit wherein the gases flowing through said conduit are heated either directly or indirectly by said conduit heater whereby the level of heating depending on said input power to said conduit heater;

25 an ambient temperature sensor providing an indication of the exterior temperature or said controller or processor including a stored assumption used as an indication of the exterior temperature;

and said instruction (b) further comprises determining based on at least said indication of the exterior temperature the required power input to said conduit heater to deliver said gases to said patient at a level of humidity or at a temperature substantially similar to said desired level of humidity or said desired temperature;

and said instruction (c) further comprises supplying as said input power to said conduit heater a level of power substantially similar to said determined power input to said conduit heater.

5 3. A breathing assistance apparatus as claimed in claim 2 wherein said humidifier comprises a humidification chamber adapted to receive a volume of water and a water heater to heat said water to produce water vapour within said chamber in use, said gases passing through said water vapour in said chamber thereby being humidified, said instruction (a) further comprising:

- 10 i) energising said water heater to heat said water towards a first condition,
 ii) continuously monitoring said parameter or, determine a variable indicative of a property of said water heater and continually monitoring said variable, until said variable or said parameter indicates that said water has substantially reached said first condition,
 iii) determining said parameter based on at least said variable and said indication
15 of the external temperature.

4. A breathing assistance apparatus as claimed in claim 3 wherein the determination of said power to said humidifier in said instruction (b) is also based on said indication of the external temperature.

20 5. A breathing assistance apparatus as claimed in claim 3 wherein said controller or processor storing a further instruction:

- (d) continuously monitor said parameter or said variable, and when a change in said parameter or said variable is greater than a first threshold said controller or processor reverts
25 to said instruction (b) and when a change in said parameter or said variable is greater than a second threshold said controller or processor reverts to instruction (a).

6. A breathing assistance apparatus as claimed in claim 5 wherein said second threshold is based on the rate of change of said parameter or said variable with respect to time, wherein
30 when said rate of change goes over said second threshold said controller or processor reverts to said instruction (a).

7. A breathing assistance apparatus as claimed in any one of claims 3 to 6 further comprising: 4

a chamber sensor means providing an indication of the temperature of said water heater and providing an indication of the electrical power drawn by said water heater,

5 wherein said variable is indicative of said indicator of the temperature of said water heater or said indication of the power drawn by said water heater.

8. A breathing assistance apparatus as claimed in claims 1 or 2 further comprising a gas supply adapted to supply gases to said humidifier at a required pressure and resulting flow rate. 2

9. A breathing assistance apparatus as claimed in claim 8 wherein said gas supply provides an output signal representative the level of electrical output to said gas supply, said signal being supplied to said controller or processor from which the flow rate of said humidified gases is determined. 2

10. A breathing assistance apparatus as claimed in or claim 9 wherein said gas supply comprise a fan driven by a variable speed electric motor. 2

11. A breathing assistance apparatus as claimed in claim 10 wherein said estimate of the flow rate of said humidified gases is based on the current drawn by said variable speed motor. 2

12. A breathing assistance apparatus as claimed in claims 1 or 2 further comprising a gases flow rate sensor from which said estimate of the flow rate of said humidified gases is determined directly.

13. A breathing assistance apparatus adapted to deliver humidified gases at a desired level of humidity or at a desired temperature to a patient comprising:

a humidifier having an electrical input power and capable of humidifying said gases up to a level of humidity prior to delivery to said patient, said level of humidity depending on said input power to said humidifier,

a conduit for conveying said humidified gases from said humidifier to said patient,
5 and

a controller or processor including stored instructions to:

(a) determine a parameter relating to the flow rate of said gases through said apparatus;

(b) determine based on at least said parameter the required electrical power input
10 to said humidifier to deliver said gases to said patient at a level of humidity or at a temperature substantially similar to said desired level of humidity or said desired temperature;

(c) supply as said input power to said humidifier a level of power substantially similar to said determined power input to said humidifier;

(d) continuously monitor said parameter or said variable, and when a change in
15 said parameter or said variable is greater than a first threshold said controller or processor reverts to said instruction (b) and when a change in said parameter or said variable is greater than a second threshold said controller or processor reverts to instruction (a).

wherein if said change in said parameter of said variable indicates a decrease in flow a relatively short delay is caused before said controller or processor reverts to said instruction
20 (b) and if said change indicates an increase in flow a relatively long delay is caused before said controller or processor reverts to said instruction (b).

14. A breathing assistance apparatus as claimed in claim 13 further comprising:

a chamber sensor means providing an indication of the temperature of said water
25 heater and providing an indication of the electrical power drawn by said water heater,

wherein said variable is indicative of said indicator of the temperature of said water heater or said indication of the power drawn by said water heater.

15. A breathing assistance apparatus adapted to deliver humidified gases at a desired
30 level of humidity or at a desired temperature to a patient comprising:

a humidifier having an electrical input power, a humidification chamber adapted to receive a volume of water and water heater to heat said water to produce water vapour within said chamber in use, said gases passing through said water vapour in said chamber thereby being humidified, and capable of humidifying said gases up to a level of humidity prior to delivery to said patient, said level of humidity depending on said input power to said humidifier, including

a conduit for conveying said humidified gases from said humidifier to said patient, and

chamber sensing means providing an indication of the temperature of said water heater and providing an indication of the electrical power drawn by said water heater, a controller or processor including stored instructions to:

(a) energising said water heater to heat said water towards a first condition, continuously monitoring said parameter or, determine a variable indicative of a property of said water heater and continually monitoring said variable, until said variable or said parameter indicates that said water has substantially reached said first condition, and determine a parameter relating to the flow rate of said gases through said apparatus based on at least said variable and said indication of the external temperature.

(b) determine based on at least said parameter the required electrical power input to said humidifier to deliver said gas to said patient at a level of humidity or at a temperature substantially similar to said desired level of humidity or said desired temperature;

(c) supply as said input power to said humidifier a level of power substantially similar to said determined power input to said humidifier.

wherein said variable is indicative of said indication of the temperature of said water heating means or said indication of the power drawn by said water heating means and said parameter is defined as the value of said power drawn by said water heater divided by said temperature of said water heater.

16. A breathing assistance apparatus adapted to deliver humidified gases at a desired level of humidity or at a desired temperature to a patient comprising:

humidifier having an electrical input power capable of humidifying said gases up to a level of humidity prior to delivery to said patient, said level of humidity depending on said input power to said humidifier,

conduit for conveying said humidified gases from said humidifier to said patient, and
5 conduit heater having an electrical input power, and being associated with said conduit wherein the gases flowing through said conduit are heated either directly or indirectly by said conduit heater whereby the level of heating depending on said input power to said conduit heater;

controller or processor which supply said input power to said humidifier and said
10 conduit heater, and providing a control output indicative of said conduit heater being correctly connected to said controller or processor and capable of operating in according within predefined limits; and

a connector means to electrically connect said controller or processor and said conduit
15 heater and including an indicator in use connected to said control output, wherein when said conduit heater being correctly connected to said controller or processor and capable of operating in according within predefined limits said controller or processor energising said indicator.

17. A method of delivering humidified gas at a desired level of humidity or at a desired
20 temperature to a patient using an open loop controlled humidifier comprising the steps of:

(a) determining a parameter relating to the flow rate of said gas through said
humidifier;

(b) determining based on at least said parameter the required electrical power to
said humidifier to deliver said gas to said patient at a level of humidity or at a temperature
25 substantially similar to said desired level of humidity or said desired temperature; and

(c) supplying a level of power to said humidifier substantially similar to said
determined power.

18. A method as claimed in claim 17 further comprising the steps:

30 conveying said humidified gas to a patient;

heating the conveyed gas either directly or indirectly using a conduit heater;

sensing or making an assumption of the exterior temperature;

and said instruction (b) further comprises determining based on at least said indication of the exterior temperature the required power input to said conduit heater to deliver said gas to said patient at a level of humidity or at a temperature substantially similar to said desired level of humidity or said desired temperature;

and said instruction (c) further comprises supplying as said input power to said conduit heater a level of power substantially similar to said determined power input to said conduit heater.

19. A method as claimed in claim 18 wherein said humidifier comprises a humidification chamber adapted to receive a volume of water and water heater to heat said water to produce water vapour within said chamber in use, said gas passing through said water vapour in said chamber thereby being humidified, said instruction (a) further comprising:

i) energising said water heater to heat said water towards a first condition,
ii) continuously monitoring said parameter or a variable indicative of a property of said water heater, until said variable or said parameter indicates that said water has substantially reached said first condition,

iii) determining said parameter based on at least said variable and said indication of the external temperature.

20. A method as claimed in claim 19 wherein the determination of said power to said humidifier in said instruction (b) is also based on said indication of the external temperature.

21. A method as claimed in claim 20 further comprising the step:

(d) continuously monitoring said parameter or said variable, and when a change in said parameter or said variable is greater than a first threshold revert to step (b) and when a change in said parameter or said variable is greater than a second threshold revert to step (a).

22. A method as claimed in claim 21 wherein said rate of change or said change in said parameter indicates a decrease in flow said controller or processor pauses for a first delay before said controller or processor reverts to step (a) and if said rate of change or said change

indicates an increase in flow said controller or processor pauses for a second delay before said controller or processor reverts to step (a), said second delay being longer than said first delay.

23. A method as claimed in claim 22 wherein said second threshold is based on the rate of change of said parameter or said variable with respect to time, wherein when said rate of change goes over said second threshold revert to step (a).

24. A method as claimed in claim 17 further comprising the step of supplying gas to said humidifier at a required pressure and resulting flow rate.

25. A method as claimed in claim 24 further comprising the step of determining the level of electrical power required to supply said gas at a required pressure and resulting flow rate, from which the flow rate of said humidified gas is determined.

26. A method as claimed in claims 25 wherein said gas is supplied by a fan driven by a variable speed electric motor.

27. A method as claimed in claim 26 wherein said estimate of the flow rate of said humidified gas is based on the current drawn by said variable speed motor.

28. A method as claimed in claim 26 wherein said estimate of the flow rate of said humidified gas is determined directly from a gas flow rate sensor.

29. A method as claimed in claim 19 further comprising the step of:
sensing the temperature of said water heater and providing an indication of the electrical power drawn by said water heater,
wherein said variable is indicative of the temperature of said water heater or said indication of the power drawn by said water heater.

30. A method as claimed in claim 29 further comprising the step of:

sensing the temperature of said water heater and providing an indication of the electrical power drawn by said water heater,

wherein said variable is indicative of the temperature of said water heater or said indication of the power drawn by said water heater.

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31. A method of connecting a conduit heater within a conduit to a humidifier comprising the steps:

providing an electrical connection between said conduit heater and said humidifier;
and

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indicating whether conduit heater being correctly connected and capable of operating in according within predefined limits.

32. A breathing assistance apparatus adapted to deliver humidified gas at a desired level of humidity or at a desired temperature to a patient using open loop control comprising:

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humidifier having an electrical input power and capable of humidifying said gas up to a level of humidity prior to delivery to said patient, said level of humidity depending on said input power to said humidifier,

means for determining a parameter relating to the flow rate of said gas through said apparatus;

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means for determining based on at least said parameter the required electrical power input to said humidifier to deliver said gas to said patient at a level of humidity or at a temperature substantially similar to said desired level of humidity or said desired temperature;

means for supplying as said input power to said humidifier a level of power substantially similar to said determined power input to said humidifier.